

Claims

1. A method for bonding parts together, the method comprising the steps of:

(a) applying at least a first chemical element layer of an intermetallic compound to a first part;

5 (b) applying at least a second chemical element layer of the intermetallic compound to a second part;

(c) placing the second part on the first part so that the chemical element layers contact each other;

10 (d) heating the parts from a storage temperature to a bonding temperature which is slightly above a first melting temperature that melts the chemical element layer of one of the first and second parts into a liquid mixture having a composition that varies with time during heating due to the formation of the intermetallic compound therein by progressive incorporation of the other one of the first and second chemical element layers into the mixture, the first melting temperature of the liquid mixture increasing with time as the composition changes until the
15 melting temperature of the liquid mixture is about equal to the bonding temperature thereby solidifying the liquid mixture into a bond; and

(e) holding the parts at a holding temperature which is higher than the storage temperature to maintain diffusion of the other one of the first and second chemical element layers into the bond thereby forming a quantity of the intermetallic compound in the bond
20 which raises the melting temperature of the bond to a desired usage temperature that is substantially above the first melting temperature.

2. The method according to claim 1, wherein one of the at least first and second chemical element layers comprises a binary solder mixture which melts at the first melting temperature.

3. The method according to claim 2, wherein the binary solder mixture includes a sequence of chemical element layers each comprising a single chemical element of the binary solder mixture, the chemical element layers forming a binary mixture close to the eutectic point of the chemical elements when melted at the first melting temperature.
- 5 4. The method according to claim 3, wherein the chemical element layers are gold and tin which form a binary solder mixture close to the eutectic point of gold-tin when melted at the first melting temperature.
5. The method according to claim 2, wherein the other one of the at least first and second chemical element layers comprises a solder quenching layer.
- 10 6. The method according to claim 5, wherein the solder quenching layer chemical element is a transition element selected from the group consisting of platinum, iron, cobalt, and nickel.
7. The method according to claim 5, wherein the transition element comprises platinum.
8. The method according to claim 1, wherein one of the first and second parts comprises a common base part and the other one of the first and second parts comprises
15 one of a plurality of component parts, the method further comprising the steps of sequentially bonding remaining ones of the component parts to the common base part using steps (a)-(e), wherein the bonds between the component parts and the common base part remain unmelted during steps (a)-(e).
9. The method according to claim 8, wherein the component parts and the common
20 base part form a hybrid optoelectronic circuit.
10. The method according to claim 9, wherein one of the first and second parts comprises a hybrid optoelectronic circuit and the other one of the first and second parts comprises a package.
11. A hybrid optoelectronic circuit comprising:
25 a common base part; and

a plurality of component parts bonded to the common base part by bonds at least partially composed of an intermetallic solder compound.

12. The circuit according to claim 11, wherein the intermetallic solder compound is a ternary solder intermetallic compound

5 13. The circuit according to claim 12, wherein the ternary intermetallic solder compound includes gold, tin, and an element selected from the group consisting of platinum, iron, cobalt and nickel.

10 14. The circuit according to claim 11, further comprising a housing for packaging the circuit, the common base part being bonded to the housing by bonds at least partially composed of the intermetallic solder compound.

15. The circuit according to claim 14, wherein the intermetallic solder compound is a ternary intermetallic solder compound.

15 16. The circuit according to claim 15, wherein the ternary intermetallic solder compound includes gold, tin, and an element selected from the group consisting of platinum, iron, cobalt and nickel.

17. A solder useful in kinetically controlled bonding of parts, the solder comprising:
a plurality of chemical element layers;

at least one of the chemical element layers defining a binary solder for application to a first part, the binary solder having a first melting temperature; and

20 another one of the chemical element layers defining a solder quenching layer for application to a second part;

wherein the solder formed by the chemical element layers has a usage temperature which is substantially higher than the first melting temperature of the binary solder.

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18. The solder according to claim 17, wherein the binary solder comprises a sequence of chemical element layers each comprising a single chemical element of the binary solder, the chemical element layers forming a binary mixture close to the eutectic point of the chemical elements when melted at the first melting temperature.

5 19. The solder according to claim 18, wherein the chemical element layers are gold and tin which form a binary solder mixture close to the eutectic point of gold-tin when melted at the first melting temperature.

20. The solder according to claim 17, wherein the quenching layer comprises an element selected from the group consisting of platinum, iron, cobalt and nickel.

10 21. The solder according to claim 17, further comprising a wetting layer.

22. The solder according to claim 21, wherein the wetting layer comprises gold.

23. The solder according to claim 17, further comprising an anti-oxidation layer.

24. The solder according to claim 23, wherein the anti-oxidation layer comprises platinum.

15 25. The solder according to claim 17, wherein the solder comprises a ternary compound.